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DYMO Routing Protocol in Manets based on Random Forest Classifier Machine Learning Technique

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Abstract:

Mobile Ad-hoc Network is a structure less freestanding ad-hoc network through which nodes converse with one another via unattached links without requiring any base station or access point. Infrastructure less, decentralized control, dynamic topology are few MANETs properties. Due to free movement of nodes, topology changes which leads to route failure and the performance of the network decreases which becomes a very challenging task in MANET. So best routing protocol is needed for route discovery between mobile nodes. The best routing path for sending data in MANETs can be achieved via Random Forest Classifier machine learning technique. This paper reviews the working of DYMO routing protocol. Further we presented Random Forest classifier machine learning technique.

Keywords: MANETs, Routing protocols, DYMO, Random Forest classifier.

1. Introduction

MANETs is a limited temporary wireless network in which mobile nodes make contact with one another without any centralized administration node. MANET is a Greek word which means “for this,” or “for this purpose only”. The MANET's construction is depicted in figure1a. The MANET network has several characteristics, including a dynamic topology, reduced infrastructure, decentralized control, and constrained bandwidth and storage. A router’s function is done by mobile nodes which works as a forward packet to other nodes in the network. No specialized routers, servers, access points, base stations, or cables are needed for this process. They follow peer-to-peer communication method with devices that are in the range. In their radio range an intermediary device can be deployed for the communication to the device which is beyond their range [12].

A primary issue is node availability; sometimes a node is in range, and other times it is not. Another issue is that nodes in MANETs need more battery life and electricity because of the network's changing topology [9].

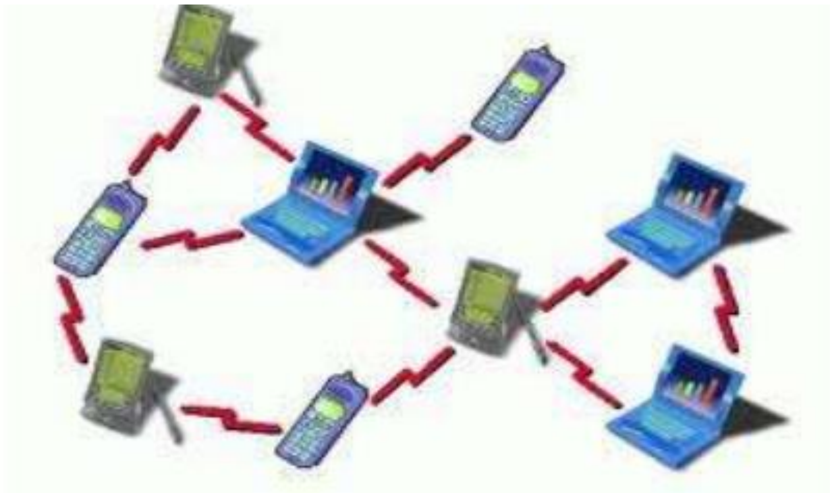

Figure 1a: Mobile Ad-hoc Network

Because of features like quick deployment and adaptable nature makes them useful in large number of applications like automatic battlefields, searches by police force, floods, fire etc, status, diagnosis from the hospital database, remote sensors for weather, cab networks, sports stadiums, mobile offices, vehicular computing, conference rooms, meetings etc. [13].

This paper provides centre of attention on the DYMO routing protocol of MANET and machine learning techniques. Because of the portable nodes, decentralized control, and dynamic topology of MANETs, routing is a challenging problem. MANET's routing protocol governs how mobile nodes choose which path to take while routing packets between other nodes [8]. The goal of current MANETs routing protocols research is to identify the most effective path between mobile nodes. There are three types of routing procedures which are distinguished as Reactive, Proactive, Hybrid routing protocols [8][2]. The principal target of the paper is to provides the evaluations of working of DYMO routing protocol and machine learning strategies.

This paper is categorized as follows: Section II describes the MANET routing protocols, section III and IV explains the working of DYMO routing protocol and Random Forest Classifier machine learning technique. Finally, V section explains the summary and future perspective of the paper.

2. MANET Routing Protocols

Transmitting data or packets from a source node to a destination node is known as routing. Due to the frequent topological interchanges in Ad-Hoc networks, packet routing becomes challenging. Routing protocol chooses the most effective route to the destination while simultaneously managing data flow in networks [9]. Three categories primarily distinguish topology-based routing protocols are shown in figure 2a:

a) Reactive protocols
b) Proactive protocols
c) Hybrid protocol

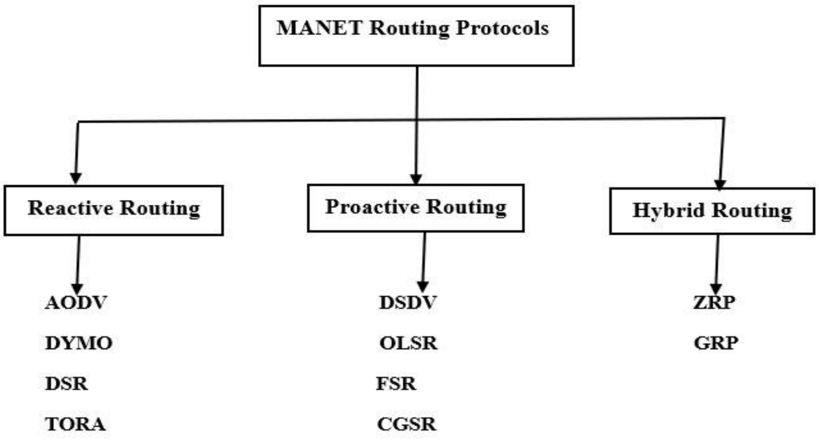

Figure 2a: Categorization of MANET Routing Protocols

- **Reactive Routing Protocols:** Reactive protocols build routes when they're needed. Put another way, it initiates the route discovery process for packets being sent from source to destination. The path continues to make sense till the destination reached or it is no longer required. AODV, DYMO, DSR and TORA are incorporated in Reactive Protocols which are used now a days [9]**.**

- **Proactive Routing protocols:** In proactive protocols, every node provides routing tables that incorporate the routing data of the network's other nodes. Every node updates its routing table frequently to maintain the most recent version of a network. These protocols include DSDV, OLSR, FSR, and CGSR, as examples [8].

- **Hybrid Routing protocols**: Hybrid routing protocols are created by amalgamation of proactive and reactive protocols. These protocols are typically used to offer hierarchical routing, while flat and hierarchical routing are also possible. ZRP and GRP are two examples [13][8].

3. Dynamic MANET On Demand Routing Protocol (DYMO)

Perkins & Chakeres have suggested the DYMO routing protocol as an improvement over the current AODV protocol. It is still updated today and is also referred to as the AODV or ADOVv2 successor. Like its predecessor, DYMO functions in a similar manner. AODV doesn't include any further changes to the current functionality, but it also operates much more simply. The DYMO protocol is entirely reactive, meaning that routes are calculated only when needed. In contrast to AODV, DYMO operates only on the basis of sequence numbers that are assigned to each packet and does not permit pointless HELLO messages. This routing mechanism is reactive in nature, computing unicast routes only when needed. Sequence numbers are used to guarantee loop freedom. It grants mobile adhoc network node-to-node multi-hop unicast routing. Route maintenance and discovery are the rudimentary functions [12].

a) DYMO Route Discovery Process

Apart from the path accumulation aspect, the DYMO and AODV route discovery are extremely similar. The DYMO route finding procedure is depicted in Figure 3a. The near neighbours of a source receive an RREQ message if the source lacks a route entry to a destination. An RREP message is returned by a neighbour who has access to the destination; if not, an RREQ message is propagated [12].

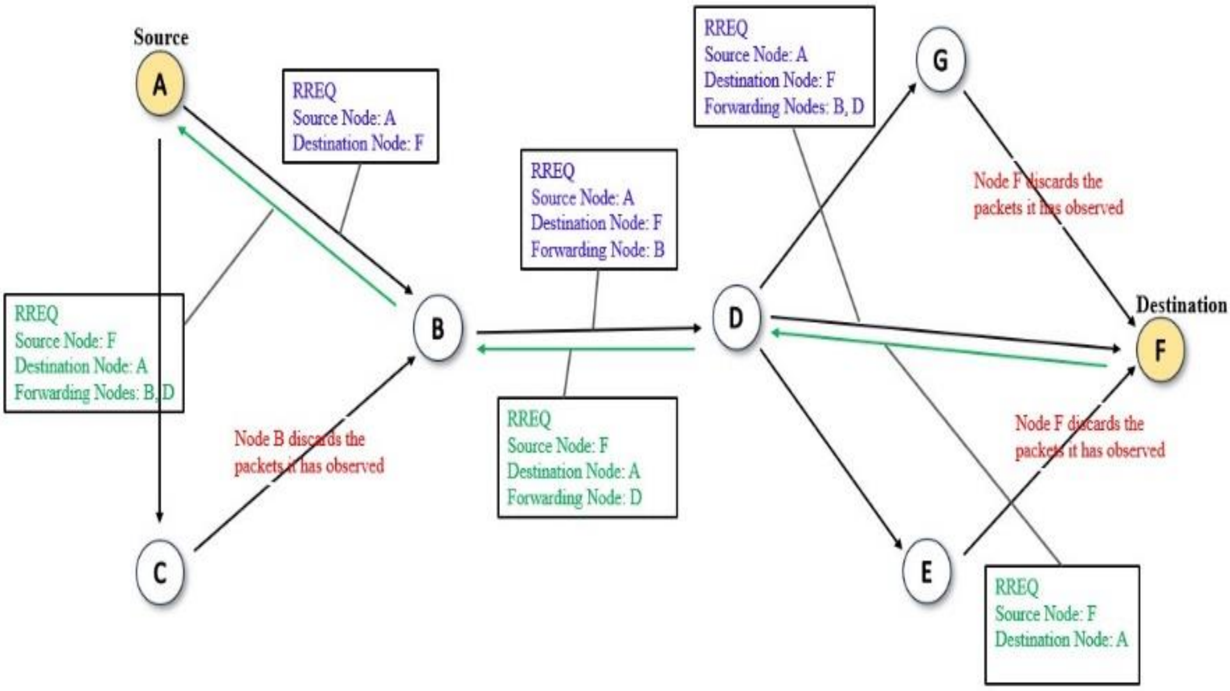

Figure 3a: DYMO Route Discovery Process

In order to interact with destination node F, source node A first looks up the destination node's route entry in the routing chart. If it cannot locate a route, it broadcasts RREQ message to nearby nodes. Every node attaches its address to the RREQ message that it broadcasts throughout the network. Every node that broadcasts an RREQ message records a backward path, as seen in figure 3a. Ultimately, destination node F creates an RREP message upon receiving an RREQ message, transmits it over the backward path, and proceeds with the path accumulation process.

Every node on the path is aware of its path to the other nodes due to the progressive path constructed by it. One unique aspect of the DYMO protocol is its energy efficiency. Any node with low energy will not take part in the route discovery process, nor will it forward any RREQ messages for the process; instead, it will just observe incoming RREP messages and update the routing database for further usage [1].

b) DYMO Route Maintenance Process

When a link failure happens in the constructed path during the route maintenance process, the node generates an RERR message and multicasts it to the nodes that are affected by the link failure. After getting this notification, every node modifies its routing databases and removes the broken link's routing record. The source node will now cease transmitting data via this path and, if necessary, will restart the route discovery procedure [10].

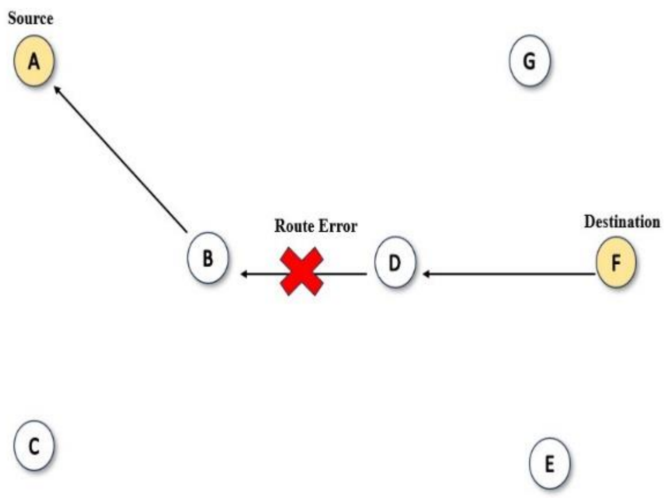

Figure 3b: DYMO Route Maintenance Process

Figure 3b illustrates that although node B received a packet from node A, the route from node B to node D was discovered to be broken. After then, node B creates an RERR message, which it then sends to node A, the source. Routing table is updated by every single intermediate node and deletes the fragmented linkage entry. For finding a new route from the source to the destination, the source node will restart the route discovery process [1].

4. Random Forest Classifier Machine Learning Technique

An enlarged decision tree, known as a random forest, future occurrences can be forecasted using countless classifiers in order to provide predictions that are accurate and right. The Random Forest methodology, as its name suggests, is a supervised classification method that groups data by building several classifiers in an effort to obtain a high prediction accuracy. This method is used with a test data set, building the trees and combining the individual results to predict the class label. It is not worthy and could result in worse accuracy to categorize a lot of data with a single classifier. Adaboost and bootstrapping techniques are used by Random Forest to build numerous classifiers [4].

According to Leo Breiman and Adele Cutler a set of decision trees is built which are further used to classify by combining the "random subspace method" and the "bootstrap aggregating method" [7].Random forest is combination of strategies that uses a number of instances of decision trees, each randomly selected from a different portion of the training set. Bootstrapping samples are what these examples are known as. Generally, all of the bootstrapped samples vote to determine the final results [3].

The Random Forest methodology provides the mechanism for building the decision tree that follows.

- Assume that there are **N** occurrences of training data in each sample. In the input dataset **M** is the number of attributes that is provided.
- The number of factors in the input that determine which attribute is chosen next at each tree node is m, if m is less than M.
- A replacement tree is constructed for each sample once the training data has been gathered.
- For each tree node, choose **m** attributes at random for that specific node.

- The optimal split is calculated based upon the **m** input qualities of the example dataset.
- Without any pruning, every tree is growing [4].

The Random Forest approach has several advantages:

- More accurate.
- Quick to manage large datasets.
- Works with hundreds of input variables with ease and efficiency.
- Offers details regarding variables that are significant and excluded from the classification.
- Gives techniques for estimating data that is absent.
- Manages missing data while maintaining accuracy [4].
- Reduces the negative rate and increases the positive rate of classification.
- The tendency to overfit huge noisy data [5].

The Random Forest approach is visually represented in the following diagram, as seen in figure4a.

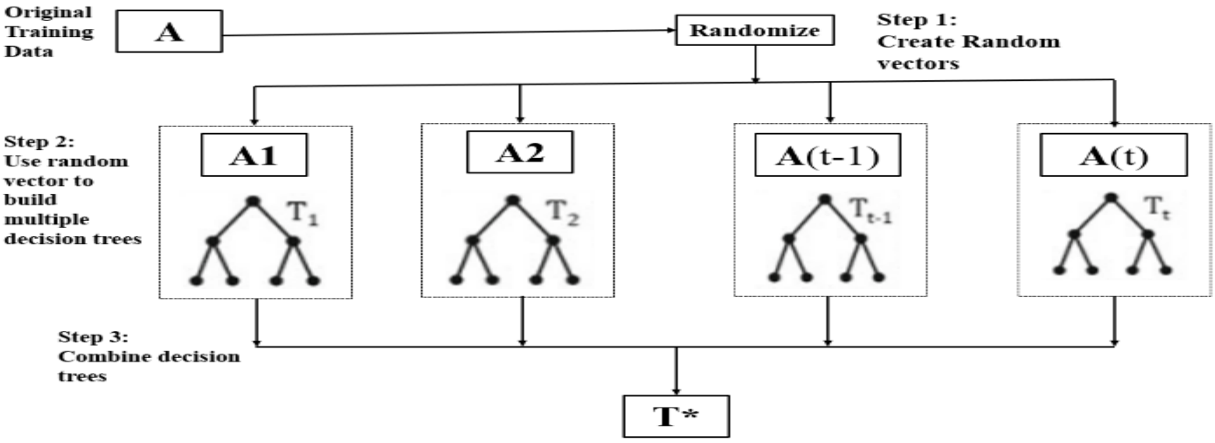

Figure 4a: The Random Forest approach depicted

Random forest is most effective during reviewing of complex data structures hidden in a basic record with fewer than 10,000 rows but potentially millions of columns are present at that time [6]. A powerful ensemble learning technique, can provide several noteworthy advantages using the DYMO protocol in MANETs:

- **Improved Route Selection:** To analyse several parameters (such as signal strength) Random Forest plays a vital role which will improve routing choices.
- **Predictive Analytics:** DYMO is enabled to proactively reroute traffic and steer clear troublesome paths after Random Forest reckon on possible network congestion or connection failures by taking account of past data and patterns.
- **Real-Time Adaptation:** Random Forest continuously learns from fresh data, enabling it to rapidly adjust to changing network conditions. Due to this, routing decisions are guaranteed to stay optimal even in the extremely dynamic settings found in MANETs.
- **Handling Mobility:** Routes will remain stable and are less likely to break irrespective of node movement by algorithm which keeps an eye on node mobility patterns

- **Fault Tolerance:** Identifications of irregular packet loss or delays, among other anomalies in network behaviour, that may point to malicious activity or connection failures can be done by Random Forest and DYMO to act quickly to address the issue.
- **Security:** Improvement in network security can be done by Random Forest which assist DYMO to steer clear of vulnerable nodes by spotting patterns linked to attacks (such as misbehaving routing).

5. Summary and Future Perspective

In this paper, the working of DYMO routing protocols have been covered including proper discussion and set of instructions. We also covered machine learning technique known as Random Forest Classifier. Keeping in view of dynamic topology, lack of fixed infrastructure, and decentralized control makes impracticable for one routing protocol to be the optimal option in every situation. Thus, the field of MANET research is expanding rapidly. Strengthening of DYMO protocol in MANET's using Random Forest Classifier machine learning technique offers extraordinary improvement in network performance. By leveraging the capabilities of Random Forest Classifier, python plays a vital role in accurately predicting network conditions, optimizing routing decisions, and improve the overall efficiency of the DYMO protocol. The integration of machine learning allows for adaptive and intelligent routing, which plays pivotal role in the dynamic and in unpredictable environments of MANETs. We hope that researchers working on the DYMO protocol will find this paper useful.

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